indicates the way to the discovery of fresh facts. The assumption is that each atom in a crystalline structure acts as a centre of operation of two opposing forces: (*a*) a repellent force, attributable to the kinetic energy of the atom, and (*b*) an attractive force, both forces, like gravity, being governed by some inverse distance law. Such an assumption forms an essential part of the classical work of Clerk Maxwell and van der Waals on the kinetic theory of gases and liquids. Its application to solid crystalline substances, where it must be applied in conjunction with the principle of structural homogeneity, was made by Barlow and myself in 1906.

The operation of the assumption just stated is readily visualised by considering the simplest possible case, that, namely, of a crystalline element each molecule of which consists of but one atom and in which all the atoms are similar. Consideration of this kind of case shows that the set of identically similar centres of attracting and opposing forces will be in equilibrium when one particular simple condition is fulfilled; the condition is that, with a given density of packing of the centres, the distance separating nearest centres is a maximum. Two homogeneous arrangements of points fulfil this condition, and these exhibit the symmetry of the cubic and the hexagonal crystalline systems.

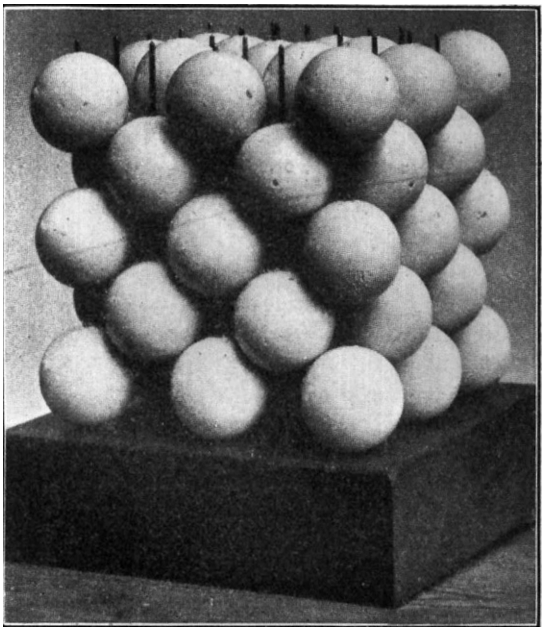

FIG. 1.

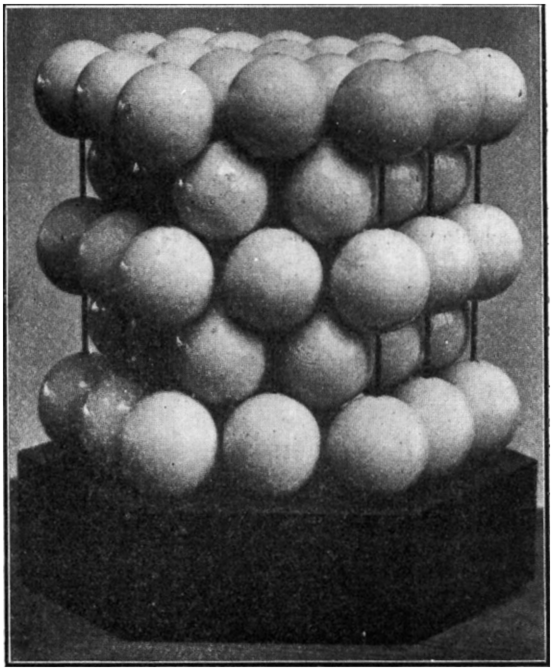

FIG. 2.

Since the nature of the two arrangements of points is not easily realised by mere inspection, the systems must be presented in some alternative form for the purpose of more clearly demonstrating their properties; this is done conveniently by imagining each point in either arrangement to swell as a sphere until contact is made with the neighbouring points. The two arrangements then become those shown in Figs. 1 and 2, and are distinguished as the cubic and the hexagonal closest-packed assemblages of equal spheres; they differ from all other homogeneous arrangements in presenting maximum closeness of packing of the component spheres. The equilibrium condition previously remarked—that, with a given density of distribution of the force centres in space, the distance separating nearest centres is a maximum—is revealed in the assemblages of spheres as the condition that the spheres are arranged with the maximum closeness of packing.

A further step is yet necessary. Each point in the arrangements considered is regarded as the mean centre of an atom of the crystalline element, but the assumption originally made states nothing about the magnitude of the atom itself; it is therefore convenient to regard the whole of the available space as filled by the atoms, without interstices. This is conveniently done by imagining tangent planes drawn at each contact of sphere with sphere, so partitioning the available space into plane-sided polyhedra, each of which may be described as the domain of one component atom. The twelve-sided polyhedra thus derived from the cubic and the hexagonal assemblages represent the solid areas throughout which each atom exercises a predominant influence in establishing the equilibrium arrangement.

(*To be continued.*)

NOTES.

A REUTER telegram states that the New Zealand meeting of the British Association has been cancelled, and that the members will return home after visiting Brisbane and Melbourne.

WE deeply regret to have to record the death, at Torquay, on August 14, of Mr. A. J. Jukes-Browne, F.R.S.

THE death is reported, in his sixty-fourth year, of Dr. Franklin W. Hooper, director since 1889 of the Brooklyn Institute of Arts and Sciences. He had previously been professor of natural science at Adelphi College, Brooklyn. He was the organiser of the Brooklyn Museum of Arts and Sciences, the Brooklyn Children's Museum, and the Brooklyn Botanic Garden. He had also taken a prominent part in the administration of the Brooklyn Board of Education and the Brooklyn Public Library.

REV. DR. HORACE CARTER HOVEY, an American geologist who had made a special study of cave formations, has died at Newburyport, Mass., at the age of eighty-one. He contributed geological articles to the ninth, tenth, and eleventh editions of the *Encyclopædia Britannica,* and was the author of several volumes on the mammoth cave of Kentucky.

THE death is announced of Dr. R. F. Harper, professor of Assyriology in the University of Chicago since 1892. In 1906 he was appointed director of the American School of Archæology at Jerusalem. He will be chiefly known by the publication of the texts of the Assyrian letters and reports of the reigns of Sargon, Sennacherib, Esarhaddon, and Ashurbanipal, preserved in the British Museum. Thirteen volumes have been published, and Prof. Harper was finishing the fourteenth at the time of his death. This volume will be issued in due course, together with the fifteenth volume, dealing with Assyrian Palæography, which he had planned.

THE Iron and Steel Institute has been obliged to abandon the holding of its proposed autumn meeting in Paris.

IN consequence of the war, the publication of the *British Pharmacopoeia,* 1914, has been indefinitely postponed. Advance copies will not, therefore, be accessible to the public for inspection as had been arranged. Due notice will be given as soon as it is decided that the time has arrived when the work shall be published.

A CIRCULAR has been issued by the Council of the Institution of Electrical Engineers to the members of the institution, pointing out two directions in which the members may be of great service to the nation at the present time, first, by placing their services as electrical engineers at the disposal of the War Office and the Admiralty, and, secondly, by being ready to fill vacancies in public services, electric power stations, tramways, railways, etc., caused by the calling up of the Reserves and the Territorial Forces. With the view of being ready to assist the authorities and the public services, the Council has decided to prepare classified lists of suitable men, and for this purpose has asked members who are in a position to assist in the directions indicated, to fill in and return a form giving full particulars of the occupations for which they are fitted. Not only are members of the institution required, but as many other qualified men as possible. Further information may be obtained from the Secretary of the Institution of Electrical Engineers, Victoria Embankment, W.C.

WE learn from *Engineering* that a scheme has been set on foot for the founding of an Australian Institution of Engineers.

M. L. TESTUT, Professor of Anatomy in the University of Lyons, contributes to *L'Anthropologie* (vol. xxv., January–April, 1914), under the title of "Dissection d'un Imbécile," a careful study of the skull and brain of an idiot, aged 69, who died at the General Hospital in 1886. The article is well illustrated and contains a large amount of statistical information. The writer claims that he has gained important results by supplementing his examination of the brain by that of other organic systems.

THE Carnegie Institution of Washington has just published "A Reconstruction of the Nuclear Masses in the Lower Portion of the Human Brain-stem," by Mr. L. H. Weed, of the Harvard Medical School. This valuable publication embodies the results of an extremely careful and laborious piece of work in a field in which the labourers are comparatively rare. The majority of previous studies deal only with plotted limits and not with actual morphology. Mr. Weed, however, by means of the wax-plate method, has constructed an accurate and enlarged model of the nuclear masses in the medulla and pons from a series of more than 2000 serial sections—40 microns in thickness, and stained by the Weigert-Pal method—comprising one of the "loan collections" in the anatomical department of the Johns Hopkins Medical School. As this is practically a purely morphological study, the text, for the most part, is descriptive, and contains no controversial or hypothetical matter. The six coloured plates, comprising fourteen figures, show different aspects of the model and cross-sections at various levels, and reproduce the more important features and relations of the nuclear matter in the brain-stem.

IN vol. viii., Nos. 2 and 3, of the *Quarterly Journal of Experimental Physiology,* there are four articles dealing with the internal secretion of the ductless glands. The most conclusive are those of P. T. Herring, who differentiated between the extracts of the intermediate and posterior segments of the pituitary body of the ox by the effects, which these produced, on the uterus of the virgin rat, and on the blood-pressure and volume of the kidney in the cat, respectively. T. Graham Brown has contributed two further elaborate studies on the nervous system, dealing with the rhythmic movements in flexor and extensor muscles under certain conditions. He holds that similar rhythmic phenomena underlie the act of mammalian progression, walking, galloping, etc. Rhythmic contraction has been demonstrated by J. A. Gunn and S. W. F. Underhill in the circular muscle—completely freed from nerve cells—of the small intestine of the cat many hours after its removal from the body. The journal contains other articles of an interesting but highly technical character.

THE first part of the second volume of the zoological section of the Natural History Report of the British Antarctic (*Terra Nova*) Expedition, 1910, published by the trustees of the British Museum, is devoted to a list of the collecting stations, drawn up by Dr. S. F. Harmer and Mr. D. G. Lillie, the latter of whom served in the expedition. It comprises twelve 4to pages and four maps, the total number of stations being 357, commencing near the western mouth of the English Channel and extending close to lat. 80° S. The greater portion of the stations were for plankton-collecting, but the list includes a certain number of localities at which specimens were obtained by the shore-party. During the first sorting of the collection a system of numbering was adopted which has not proved suitable for more permanent use, and these provisional station-numbers, which are entered in the third column of the tables, have accordingly been replaced by others, which occupy the second column, and correspond with those in the maps. The plankton-nets used are referred to the number of meshes per linear inch, the "full-speed net" having no fewer than 180.

IN continuing his article on pattern-development among mammals and birds in the August number of the *American Naturalist,* Dr. G. M. Allen suggests that the light-coloured rump-patch so common among ungulates, and generally regarded as a "recognition-mark," is probably due to the total inactivity of the primary pigment-patches usually covering that region of the body. Among the ground-squirrels, or chipmunks, a transition may be observed from a uniformly grizzled coat to one indistinctly spotted, then to one with rows of white spots, and finally to others with broken or complete longitudinal white stripes. Such stripes the author believes to be due to the development, not of breaks between the primary pigment-patches, but of small pigmentless spots, which, in their fullest intensity, unite into stripes. On the other hand, it is quite conceivable that the reverse condition—the breaking up of stripes into spots—may likewise occur in some instances.

IN "A Fourth General Adjustment of the Precise Level Net in the United States and the Resulting Standard Elevations," by W. Bowie and H. G. Avers (pp. 328; Special Publication No. 18; Washington: Government Printing Office, 1914), the results of the latest adjustment of the level net of the United States are discussed, all precise levelling done previous to 1912 being included except those lines which do not form portions of closed circuits. On this occasion the orthometric correction has been applied to standard altitudes westward of the Mississippi River, since this correction is found to be needed in high altitudes. Altitudes are now given both in feet and metres, the former being added for the convenience of surveyors and engineers who may use the results. Instruments and method of levelling have been the same as in preceding years; the rate of work has varied from 56 to 84 miles a month, according to the character of the country traversed, and the average cost has been rather above 2*l*. per mile. For the present publication, after the orthometric correction had been applied to the levelling westward of the Mississippi, an adjustment of the entire net was made, using the weights as determined by the 1907 adjustment. A special adjustment was also made of altitudes in the western part of the country with very satisfactory results. The accidental and systematic errors of the levelling, which has been carried out by the Coast and Geodetic Survey since 1899, has, in this report, been computed in accordance with the resolutions adopted at the Conference of the International Geodetic Association, held at Hamburg in 1912, and for levelled lines totalling 15,028 kilometres, the probable accidental error is given as ±0·713 mm. per kilometre, and the probable systematic error as ±0·080 mm. per kilometre. It is, however, pointed out that this systematic error cannot include all sources of error, since the probable accidental error for a kilometre, as found in the general adjustment of 1912, is considerably larger than that obtained by the International formula.

IN an interesting paper in the *Popular Science Monthly* for August Dr. William H. Ross, of the United States Bureau of Soils, deals with the origin of nitrate deposits, more particularly of the famous Chilean beds, which occur in the deserts of Atacama and Tarapaca, and still form the principal source of the world's supply of nitre. In the year 1912, for example, the total quantity exported from Chile was 2,485,860 tons. The origin of these enormous deposits is still uncertain; the various theories which have been put forward to explain their existence are dealt with in some detail in the present paper. It has been suggested that they have been formed by the nitrification of immense deposits of sea-weed, of guano, or of the dung of vicuñas and llamas, but it is more probable that they represent the concentrated fertility of the thousands of square miles of land between the watershed of the Andes and Coast Range, the nitrates formed in these regions being washed out by the periodical mountain floods, which occur every seven or eight years, and subsequently recovered by the evaporation of the leachings in the lower levels, where the nitrates are found.

AMONG palæontological papers it may be mentioned that the latest issue of the *Palaeontologia Indica* (ser. 15, vol. iv., part ii., fasc. 4) is devoted to the description, by Dr. K. Holdhaus, of the lamellibranchs and gastropods of the Silurian Shales of Spiti, N.E. Himalaya, in which a number of new species, and at least one new genus, are named. Also that the Egyptian Survey Department has issued the first part of a catalogue of the invertebrate fossils of Egypt represented in the collections of the Museum of Geology at Cairo, by M. R. Fourtau. This deals with Cretaceous echinoderms, a group in which the Cairo Museum is particularly rich, as the result of collections made of late years in the Sinaitic Peninsula between Gebel Tih and the Gulf of Suez. A considerable number of the specimens represent new species, all of which, together with many others, are figured.

THE joint annual report of the Forestry Branches for 1912–1913 (London: Wyman and Sons, Ltd.), is due to a recent arrangement by which the Board of Agriculture and the Office of Woods cooperate in the development of forestry in this country. The report gives an excellent historical summary of the management of the Crown woods and forests from the earliest times until 1912. This is followed by a brief account of each of the twenty forests and wooded estates that are now under the charge of the Commissioners of Woods. These properties, with a total wooded area of 65,766 acres, consist partly of the ancient hereditary estates of the Crown (New Forest, Dean Forest, Bere Woods, etc.), and partly of estates that have been recently acquired, as Inverliever Estate in Argyllshire, and Hafod Fawr Estate in Merionethshire. Instruction in forestry is provided at the Chopwell Woods, near Newcastle-on-Tyne, which was managed by the Lecturer in Forestry of the Armstrong College, and at the School for Working Foresters in the Forest of Dean, which was established in 1903, and passed out sixty-four certificated woodmen in the subsequent nine years. The most important chapter in the report is devoted to the timber trade of the United Kingdom. The annual home supply of timber is less than 20,000,000 cubic feet, and cannot be appreciably increased, unless extensive afforestation is carried out immediately, of the actual inception of which there is no sign in the report, no money being available as yet from Development Funds for such a purpose in England or Scotland. The annual import of unmanufactured timber now stands at 400,000,000 cubic feet, valued at 28,360,000*l.*, to which must be added manufactured timber, 3,400,000*l.*, and wood pulp, 4,400,000*l.*, or a total of 36,160,000*l.* annually spent on foreign timber and wood pulp. Our consumption of timber, as shown in the decennial tables of the report, has steadily grown with the progress of our industries; and during the last decade the price of timber has considerably increased. The day is not far off when coal-mining, the extension of railway and telegraph communications, building, etc., will be checked by the high price of foreign timber, the only supply available.

Discoveries connecting the pre-Cambrian fossil algal flora with the blue-green algæ of to-day are announced in a preliminary report by Dr. Charles D. Walcott, published by the Smithsonian Institution. The fossil remains of these ancient marine plants which form part of the Palæontological collections of the U.S. National Museum were collected in the Algonkian formations of the Cordilleran area of Western America, chiefly in the Big Belt Mountains of Montana. Eight genera and twelve species, new to science, are described by the author, who includes illustrations of both the ancient and modern forms for comparison. Dr. Walcott proposes to visit during the present field season the localities where these old forms of life in fossil form are found, for the purpose of continuing his investigations and to gather data for a further and more detailed report.

We have received a copy of No. 1 of a new journal dealing with biochemistry, the *Bulletin de la Société de Chimie Biologique,* which, as its name implies, is the organ of the newly formed French Biochemical Society. One of the most striking facts of the past few years is the very great development of biochemistry as a special science; this branch of chemistry has now its own journals in England, Germany, France, and the United States, all of which are regularly publishing numerous and important papers. Considering the activity of French chemists in this particular field, the existence of a special journal in which their researches may become readily available to other workers is a welcome fact. Foreign biochemists will undoubtedly wish the newly formed society every success in its efforts.

A useful paper on the climate of Lorenzo Marques (Delagoa Bay), with frequent references to the meteorological elements of South Africa, by Sr. A. de Almeida Teixeira, is published in the *South African Journal of Science* for July. The mean annual temperature, from fourteen years' observations, is 72·0°; January, 78·6°; July, 64·4°. The absolute extremes quoted are 111·9° (November) and 46·0° (July), but readings above 104° and less than 48° are exceptional. Extremes of heat are due to hot winds from N.N.W., which precede atmospheric depressions; these are immediately followed by fresh south winds with a fall at times of nearly 29° within an hour and a half. The mean annual rainfall is 26·7 in., on 77 days; the wettest month is January, with 5 in.; the driest, August, with 0·5 in. The average annual percentage of hours of sunshine is 61·3, but the instrument used is Jordan's photographic recorder, which is not directly comparable with the Campbell-Stokes burning instrument. The usual four seasons are not well marked, a better division being the warm and rainy season—October to March—and the cool and practically dry season—April to September. The author points out that the climate is more pleasant than could be expected from its geographical position, owing, among other things, to the sea breezes and the scarcity of calms, and he quotes Commander de Lacerda's view that "in winter during the period of fine weather, and with the south winds prevailing, the climate may be placed on a level with the best in the world."

The recently published Transactions of the Cardiff Naturalists' Society for 1913 contains monthly and yearly rainfall values and other details for fifty-one stations in the Society's district. The tables are arranged according to the height above sea-level; at the highest station, Tyle Brith, Brecknockshire (2350 ft.), the annual fall was 89 in.; at Cardiff, Penylan station (204 ft.), 42·1 in.; at Cadoxton, Barry (20 ft.), 32·2 in. A comparison with the averages shows that the year was abnormally wet. Climatology is indebted to Dr. E. Walford, medical officer of health, for the preparation of this useful report from data supplied by voluntary observers.

Part 3 of Publication No. 149 of the Carnegie Institution consists of a report by Prof. Carl Barus, of Brown University, on the application of interference methods of measurement in a number of branches of physics. The first is to the measurement of the index of refraction of a double refracting crystal for the extraordinary ray in terms of that for the ordinary ray, by inserting a plate of the crystal in the path of one of the interferometer beams and observing the two sets of elliptic interference fringes produced. A second is to the accurate comparison of screws, and a third to the detection and study of the motion of a resonator, or of the disc of a telephone. Attempts to detect a change in the index of refraction of rarefied air through which an electric current is passing, and measurements of the change of refractive index of air with temperature are further applications. Finally the author deals with the measurement of the deflection of an electrometer needle by interference, and shows that such an instrument will measure a few millionths of a volt.

IN connection with the development of the Langley Aerodynamical Laboratory of the Smithsonian Institution, the purpose of which, it will be remembered, is primarily to plan and conduct such theoretical and experimental investigations, tests, and reports as may serve to increase the safety and efficiency of aerial locomotion for commercial advance, national defence, and the welfare of man, a visit was paid a short time ago to various kindred institutions in Europe by Dr. A. F. Zahm, the recorder of the Langley Laboratory, accompanied by Mr. J. C. Hunsaker, of the U.S. Navy. The tour of inspection included the British, French, and German laboratories; also many of the aerodromes, aircraft factories, and aeronautical libraries, the object being the study of the latest developments in instruments, methods, and resources used and contemplated for the prosecution of scientific aeronautical investigations. The results of their observations are embodied in No. 2273 of the Smithsonian Miscellaneous Collections.

BULLETIN No. 8 of the Mellon Institute of Industrial Research deals with some engineering phases of Pittsburg's smoke problem. In this district more bituminous coal is used than in any other district of like size in the world. The coal found in the neighbourhood of Pittsburg is very plentiful, cheap, and rich in volatile matter. Further, the many hills and valleys and the frequent fogs hold the smoke long after it would have been carried away in another locality having a more regular topography. The soot-fall for the twelve months ending April, 1913, at the various observation stations in Pittsburg ranges from 595 to 1950 tons per square mile. Pittsburg learned the appearance of a clean city during the brief period in which natural gas was largely employed; since 1895 the use of coal has been general again. The local authorities have made attempts since 1893 to get rid of smoke production at the pumping stations, but with little success; the Mayor reported in 1913 that one of the worst offenders against the smoke ordinance is the city of Pittsburg at the Northside light plant and the Brilliant pumping station. Of special interest is a series of photographs showing two views of each locality, one on a clear day and the other on a smoky day.

WE have received from the Cambridge University Press a copy of the second edition of Dr. G. S. Graham-Smith's "Flies in Relation to Disease: Non-Bloodsucking Flies," the first edition of which work was reviewed in NATURE of December 11, 1913. In the work as first issued an attempt was made to collect, tabulate, and examine critically the various facts and hypotheses relating to the life-histories, habits, and disease-carrying potentialities of non-blood-sucking flies, which had been published up to the end of 1912. In the present edition the work published during 1913 is dealt with in the same manner, and in addition an account of some recent unpublished observations made by the author has been added. The volume is published at 12*s*. 6*d*. net.

OUR ASTRONOMICAL COLUMN.

THE PERSEID METEORIC SHOWER.—The weather has been very favourable for tracing the progress of this shower. On August 10 there were not many meteors, though a few fine ones appeared. On August 11 there was a great increase in numbers, but the moon rose soon after 9 p.m. At Bristol Mr. Denning estimated that the total number of meteors visible to one observer between 9 p.m. and 3 a.m. on the following day must have been about 150. On August 12 the rate of meteoric apparitions had declined and the number visible in the same time was estimated at 110, but there were many detached clouds over the sky. On August 13 there were clouds at Bristol and few meteors were seen, but the Perseid shower had evidently decreased in a marked degree since the previous night. On the whole the display may be regarded as having exhibited moderate numbers with a large proportion of brilliant meteors. The radiant point showed the usual displacement to the eastward as observed on successive nights.

On August 16 meteors were abundant, and there were two active showers, one of late Perseids from 56°+59° and another of Lyrids from 279°+45°.

The observations generally have been ample this year, according to reports from many stations. Mrs. Fiammetta Wilson, at Bexley Heath, recorded the paths of no fewer than 152 meteors on the four nights from August 10–13. Two magnificent fireballs were seen by her and by Miss Grace Cook at Stowmarket on August 14, viz., a Perseid at 9.34 and a slow meteor three or four times as bright as Venus directed from a radiant in the southern sky at 9.50. The latter was also recorded by the Rev. Ivo Gregg at Walthamstow, and the following deductions have been made regarding this and a few other brilliant meteors of the recent display:—

Date	G.M.T.		Mag.	Height at first	Height at end	Path	Velocity per sec.	Radiant
	h.	m.		m.	m.	m.	m.	° °
Aug. 11	11	25	>1	72	48	38	38	47+61
12	10	22	Sirius	78	45	59	45	48+58
,,	10	33½	♀	80	54	48	40	48+57
,,	10	52½	>1	82	53	31	80	280+44
,,	11	10	1	64	49	28	14	320−4
14	9	34	♀	85	54	61	61	44+59
14	9	50	>♀	67	44	31	16	296+10

The great velocity of the Lyrid of August 12, 10 52½, is remarkably in contrast with the rate of motion of the last two meteors in the table.

THE SPECTRUM OF COMET 1914*b* (ZLATINSKY).—Dr. Slipher publishes in the Lowell Observatory Bulletin, No. 63, a description with wave-lengths of the spectrum of Zlatinsky's comet. Three spectrograms of this comet were secured at Flagstaff on the evenings of May 25, 26, and 27, using a one-prism spectrograph employed in nebular work attached to the 24-in. refractor. Vanadium and iron were used as comparison spectra, and it was possible to expose for about one and one-third hours. The wave-lengths were reduced independently from the three negatives, and all three reductions are printed in tabular form in the paper. In order to differentiate between the spectrum of the head and nucleus of the comet a long